ULTRASONIC WELDING PROCESS AND EQUIPMENT FOR CONSTRUCTION OF ELECTRON-TUBE MOUNTS

Fourth Quarterly Progress Report
For the Period
April 1 through June 30, 1963

Contract No. DA-36-039-sc86741
Order No. 19063-PP-62-8181

Placed by
Industrial Preparedness Directorate
United States Army Electronics
Materiel Agency

AEROPROJECTS INCORPORATED
West Chester, Pennsylvania

ULTRASONIC WELDING PROCESS AND EQUIPMENT FOR CONSTRUCTION OF ELECTRON-TUBE MOUNTS

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The object of this program is to design and construct prototype welding equipments and their associated accessories to perform by ultrasonic techniques the welding operations required in the assembly of electron tubes under Specifications SCS-114A and SCIPPR-15.

Contract No. DA-36-039-sc86741
Order No. 19063-PP-62-81-81

Report Prepared by: W. Rosenberg

Report Approved by: Byron Jones

ABSTRACT

Fine-wire specimens were submitted to Chatham Electronics for shock and vibration testing. Welding of heavy-wire-to-coupon specimens for shock and vibration testing was continued on receipt of additional materials.

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PURPOSES

The objectives of this Production Engineering Measure (PEM) are to:

1. Demonstrate the capability limits of ultrasonic welding to join combinations of metallic materials of interest to the electron-tube industry. This part of the work will be limited in that it will not continue exhaustive attempts to weld those combinations which might prove particularly difficult to join.

2. Analyze the welding requirements for three specific electron tubes. The three tube types selected are the Type 6080WB, 5814WB and 6205. These were selected by the U. S. Army Electronics Materiel Agency because they are widely used in military equipment, and have a record of failures due to improperly welded joints.

3. Prepare fixturing and tooling for the specific electron tubes, so that ultrasonic welding may be used in the manufacturing process.

4. Weld the parts required to assemble electron-tube mounts for the three tube types, and evaluate.

5. Build production ultrasonic welding equipment which will enable an electron-tube manufacturer to make the welded connections in a broad range of electron-tube types.

6. Install the ultrasonic welding equipment in a production company, and produce on a pilot basis with that company's personnel, a limited lot size of each of the three tubes for subsequent evaluation in accordance with applicable military specifications.

NARRATIVE AND DATA

WELDING STUDY

The welding study was completed during the last period, except for the specimens to be subjected to shock and vibration testing. Fine-wire specimens have since been submitted to Chatham Electronics. Specimens so tested will be returned to Aeroprojects for tensile-shear testing.

1. Material Procurement

Since previous supplies were exhausted, additional materials were procured for the heavy-wire-to-coupon shock and vibration test specimens. These included rhenium, tantalum, and tungsten wires of 0.060-inch diameter, and rhenium, titanium, and gold sheet of 0.060-inch thickness.

2. Tooling

No alterations were made to the tooling which had been completed as previously reported.

3. Welding

The fine-wire shock and vibration test specimens listed in Table I were welded without difficulty, using the techniques and tooling described in the Second Quarterly Progress Report (pp. 3, 7-9), and were subsequently forwarded to Chatham Electronics.

Problems were encountered in welding some heavy-wire-to-coupon specimen groups when using recently procured material. Rhenium proved especially difficult. For instance, the rhenium and tantalum wire cracked excessively; this was not experienced to such a degree with previous shipments. Rhenium and titanium sheets exhibited different qualities, and the weldments were not reproducible. Reasons for these variations are now being investigated and will be reported.

4. Weld Evaluation

Table I lists the fine-wire-to-coupon weldments which were delivered to Chatham Electronics for exposure to shock and vibration environments. The tests will be conducted in accordance with the following specifications*:

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* Previously reported in the Second Quarterly Progress Report, page 14.

Shock Test

The shock test shall be conducted on a high-impact shock machine for electronic devices. Each weldment shall be subjected to a total of 21 hammer blows of 30° (450 G) angular displacement; that is, seven blows in each of the positions X, Y and Z in any sequence.

Fatigue Test

The weldments shall be rigidly mounted on a table vibrating with simple harmonic motion at a frequency of 25 ± 2 cps with an amplitude of 0.040 ± 0.005 inch (total excursion 0.080 ± 0.005 inch). The weldments shall be vibrated for a total of 96 hours, 32 hours in each of the three positions X, Y and Z.

For the shock tests, Chatham Electronics will use a Navy fly-weight shock machine, manufactured by Taft-Pierce Manufacturing Company. The vibration tests will be conducted on a Vertical Vibrator manufactured by International Pump and Machinery Works.

The schedules for the tests, as previously reported*, are as follows:

1. Expose 3 specimens of each successfully welded combination obtained under the Basic Data evaluation to the Shock Test described under Test Specifications.

   a. Test exposures are to be made at room temperature.
   b. Test exposures are to be made without special atmospheres.

2. Tensile-shear test all surviving welds.

Vibration and Fatigue Tests

1. Expose 3 specimens of each successfully welded combination obtained under the Basic Data evaluation to the Fatigue Test described under Test Specifications.

2. Examine specimens after 60 seconds exposure in Z plane, and note failures. Resume exposure for 32 hours.

3. Expose specimens for 32 hours in Y plane.

4. Examine specimens after 60 seconds exposure in X plane, and note failures. Resume exposure for 32 hours.

5. Tensile-shear test all surviving welds.

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* Previously reported in the Second Quarterly Progress Report, page 13.

The tensile-shear tests will be conducted at Aeroprojects, using a standard Model TT-CL Instron testing machine, and the results will be compared with the base data.

ELECTRON TUBE STUDY.

Tooling for the production of the electron tubes at Chatham Electronics will be designed, and fabrication of this tooling will be started during the next report period, pending authorization from USAEMA to proceed with Phase II of the program.

CONCLUSIONS

Welding only was performed during this period. Environmental testing has begun on the fine-wire specimens which were successfully welded. With the receipt of additional material for the heavy-wire studies, this phase of welding is approaching completion.

PROGRAM FOR THE NEXT REPORTING PERIOD

Shock and vibration exposure test data will be obtained on successfully welded wire-to-coupon combinations. Authorization will be sought from USAEMA to proceed with Phase II of the program, wherein ultrasonic welding equipment, based on the Phase I Weld Evaluation and Study portion of the program, will be procured from Sonobond Corporation, a subsidiary of Aeroprojects Incorporated, and the design and fabrication of the special tooling to weld the electron tubes will be started.

Table I

LIST OF FINE-WIRE-TO-COUPON WELDMENTS
SUBMITTED TO CHATHAM ELECTRONICS

Weld Combination Materials			
Coupon	Combination No.	Wire	Wire Diameter (inch)
Copper	1A	Copper	0.0005
	2A	Gold	0.0003
	3A	Molybdenum	0.0008
	4A	"A" Nickel	0.0005
	6A	Silver	0.0015
	7A	Mild Steel	0.0015
	8A	Stainless Steel	0.001
	9A	Tantalum	0.003
	10A	Titanium	0.001
	11A	Tungsten	0.0003
Gold	12A	Copper	0.0005
	13A	Gold	0.0003
	14A	"A" Nickel	0.0005
	15A	Silver	0.0015
	16A	Mild Steel	0.0015
	17A	Stainless Steel	0.001
Molybdenum	19A	Molybdenum	0.0008
	20A	"A" Nickel	0.0005
	22A	Stainless Steel	0.001
	23A	Tantalum	0.003
	24A	Titanium	0.001
	25A	Tungsten	0.0003
"A" Nickel	26A	Copper	0.0005
	27A	Gold	0.0003
	28A	Molybdenum	0.0008
	29A	"A" Nickel	0.0005
	30A	Rhenium	0.005
	32A	Mild Steel	0.0015
	33A	Stainless Steel	0.001
	34A	Tantalum	0.003
	35A	Titanium	0.001
	36A	Tungsten	0.0003

(Continued on Next Page)

Table I (Continued)

Coupon	Combination No.	Wire	Wire Diameter (inch)
Rhenium	38A	Molybdenum	0.0008
	39A	"A" Nickel	0.0005
	41A	Stainless Steel	0.001
	42A	Tantalum	0.003
	43A	Titanium	0.001
Silver	45A	Copper	0.0005
	46A	Gold	0.0003
	47A	"A" Nickel	0.0005
	48A	Silver	0.0015
	49A	Mild Steel	0.0015
	50A	Stainless Steel	0.001
Mild Steel	51A	Copper	0.0005
	53A	"A" Nickel	0.0005
	55A	Mild Steel	0.0005
	56A	Stainless Steel	0.001
Stainless Steel	59A	Molybdenum	0.0008
	60A	"A" Nickel	0.0005
	61A	Rhenium	0.005
	63A	Mild Steel	0.0015
	64A	Stainless Steel	0.001
	65A	Tantalum	0.003
	66A	Titanium	0.001
	67A	Tungsten	0.0003
Tantalum	68A	Copper	0.0005
	69A	Molybdenum	0.0008
	70A	"A" Nickel	0.0005
	71A	Rhenium	0.005
	72A	Stainless Steel	0.001
	73A	Tantalum	0.003
	74A	Titanium	0.001
Titanium	76A	Rhenium	0.005
	77A	Stainless Steel	0.001
	78A	Copper	0.0005
	79A	Molybdenum	0.0008
	80A	"A" Nickel	0.0005
	81A	Tantalum	0.003
	82A	Titanium	0.001
	83A	Tungsten*	0.0003

(Concluded on Next Page)

* General Electric tungsten wire used.

Table I (Concluded)

Coupon	Combination No.	Wire	Wire Diameter (inch)
Tungsten	86A	"A" Nickel	0.0005
	88A	Stainless Steel	0.001
	89A	Tantalum	0.003
	90A	Titanium	0.001
	91A	Tungsten	0.0003

VISITATIONS DURING THIS REPORT PERIOD

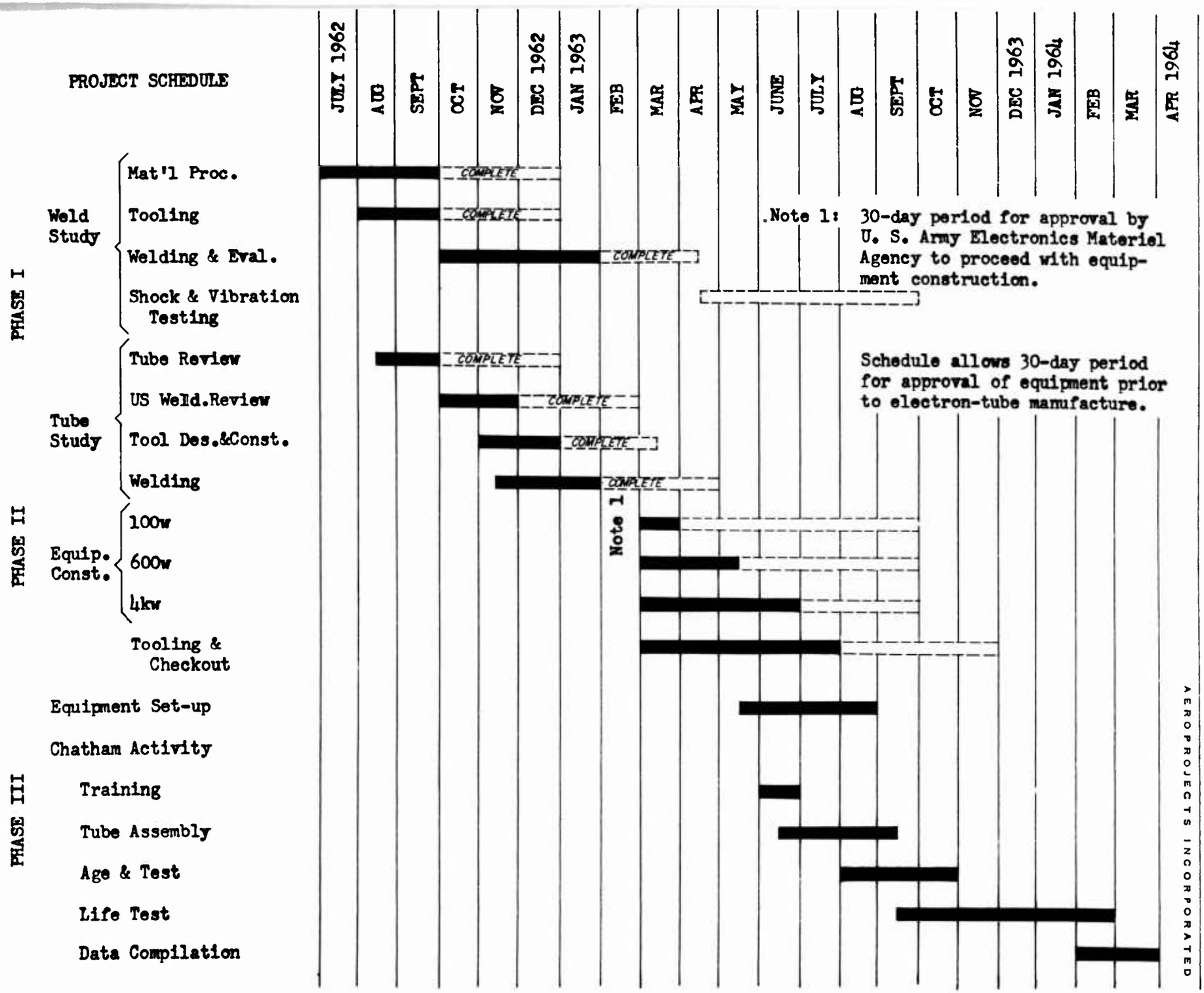
Date	Visit	Purpose of Visit
4/10/63	Mr. H. Shienbloom, USAEMA, visited Aeroprojects, West Chester, Pennsylvania	Inspect tooling and weldments. Review data and program progress.
5/31/63	W. N. Rosenberg visited Mr. H. Shienbloom, U. S. Army Electronics Materiel Agency, 225 S. Eighteenth Street, Philadelphia, Pennsylvania	Review Progress Report and technical status of program.
6/5/63	W. N. Rosenberg visited Messrs. B. F. Steiger and N. Helmstetter, Chatham Electronics, Livingston, New Jersey	Review ultrasonic welding of electron tubes.

TECHNICAL MAN-HOURS

EXTENDED DURING THIS REPORT PERIOD

NAME	PROJECT POSITION	HOURS EXPENDED THIS REPORT PERIOD
W. N. Rosenberg	Project Supervisor	51
J. Koziarski	Director Welding Lab	241*
J. G. Thomas	Metallurgist	200*
G. Sekula	Junior Engineer	12
A. L. Fuchs	Chief Design Engineer	13-1/2
C. DePrisco	Chief Electronics Engineer	1
W. B. Devine	Director of Publications	103-1/2*
N. Maropis	Physicist	11-1/2

* The major portion of these efforts during this period were expended to obtain more comprehensive data for inclusion in the Third Quarterly Progress Report.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AUG
SEPT
OCT
NOV
DEC 1962
JAN 1963
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC 1963
JAN 1964
FEB
MAR
APR 1964
PHASE I
Weld Study
Mat'l Proc.
Tooling
Welding & Eval.
Shock & Vibration Testing
Tube Study
Tube Review
US Weld.Review
Tool Des.&Const.
Welding
PHASE II
Equip. Const.
100w
600w
4kw
Tooling & Checkout
Equipment Set-up
PHASE III
Chatham Activity
Training
Tube Assembly
Age & Test
Life Test
Data Compilation
COMPLETE
Note 1
.Note 1: 30-day period for approval by U. S. Army Electronics Material Agency to proceed with equipment construction.
Schedule allows 30-day period for approval of equipment prior to electron-tube manufacture.
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